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Slot techs have one supreme advantage over technicians in most other disciplines of electronics: The easy ability to swap modules between machines in order to determine where the problem lies.

**Page 4 - Understanding Diodes, Transistors and Other Semiconductors**
Of all the basic skills and procedures in electronics, none is more important than the ability to test parts like diodes and transistors.

**Page 8 - The Ambassador, the Slot Tech and You!**
Trying to be in two places at once is pretty much standard operating procedure for a slot tech. So is constant contact with our customers, the gaming public. How well do you make the change from being the slot tech to being the ambassador of your casino?

**Page 12 - Monitor Troubleshooting Flowchart**
Run (don't walk) to your nearest photocopier, make a copy of this troubleshooting flowchart and staple it to the wall of the shop. You'll be glad you did.

**Page 14 - How Monitors Work**
The first of a multi part series, this month featuring the basics of how video slot monitors operate.

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Scott Reynolds shares his experiences as a slot tech student with Slot Tech Magazine

**Page 20 - AWP Spotlight**
From the land of fruit machines, Kinger! presents this month's program updates and improvements.

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Looking for a replacement for a Japanese transistor? Low on your stock of electrolytic capacitors? This month's contact sheet is for electronic component distributors.

# Inside This Month's Slot Tech Magazine

This month's Slot Tech Magazine presents a line-up that has something for slot techs of every skill level. There's even a little something for those who aren't yet slot techs but are considering joining the ranks.

If you're a floor tech and you're ready to take the next step up in terms of machine repair, you'll have to know about a family of components called semiconductors. As you may already know, these are parts like diodes and transistors. Beginning on page four, you'll learn all about how semiconductors work, how they fail and how to test them with your digital multimeter. You'll also learn about component specifications and how to obtain replacement parts and make component substitutions.

While we're on the subject of substitution, you'll want to read all about the science of "Swaptronics" in Bart Holden's insightful look at a Williams slant top repair.

Being a slot tech is often a challenging profession. Not only are slot techs dealing with state-of-the-art machines but with the general public as well. Frank Sutter discusses a bit about the Zen of servicing both the machines and your clientele. Turn to page eight.

This month's centerpiece is for our somewhat more advanced group. It's a generic troubleshooting flowchart for monitor repair. It's pretty self-explanatory. Just answer the questions and follow the arrows to the cause of your problem.

And speaking of monitors, intermediate level technicians who want to learn monitor repair should turn to page fourteen and read this first of many installments on the subject. Monitors are easy to understand and a lot of fun to work on, once you know how they operate.

If you are not a working slot tech now but are considering getting into the field, you'll want to check out Scott Reynold's review of the training he received at a slot tech school in Las Vegas. Does Scott feel he's ready to go to work on the slot floor? Turn to page eighteen and see.

This month's contact Sheet is

**Randy Fromm**

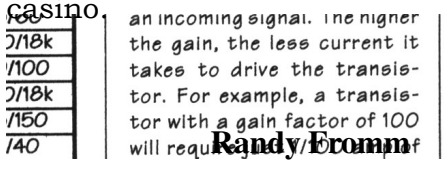
for component suppliers. These are the guys that sell the resistors, capacitors, diodes, transistors and integrated circuits. For the weird and unusual (including Japanese components) and for great prices on stuff like horizontal output transistors and MOSFETs, I highly recommend New Jersey Semiconductor Products. Semis only, no passive components.

Isle of Capri's Mike Thomas gives us a couple of tips for IGT machines in this month's SLot Tech Troubleshooting Tips.

Reporting from the other side of the Atlantic, Slot Tech's European correspondent, Kinger! reminds us of some important updates and machine improvements as the British fruit machine industry shakes off the winter blues and gets ready for the seaside holiday crowd.

If you haven't taken the time to subscribe, please do it now. The subscription form is in the back of the magazine or you may call 619.593.6131 and charge it to your credit card. You may also subscribe online at the slot-techs.com website.

Until next month, see you at the casino.




**Randy Fromm's**
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# SWAPTRONICS

## By Bart Holden

**Editors note:** Slot techs have one supreme advantage over technicians in most other disciplines of electronics: The easy ability to swap modules between machines in order to determine where the problem lies. Slot Tech Magazine contributing writer Bart Holden defines this as "swaptronics" and although this article describes a specific failure, the proceedure is directly applicable to just about all types of slot machine repairs. - rf

**Game type:**
**Williams slant top video slot**
**Problem:**
**No Video output to monitor**

I recently encountered a display problem on a Williams Monopoly slant top. The monitor was receiving voltage to the Cathode Ray Tube (CRT) however the graphics were missing.

I swapped the monitor with a known good one and the problem remained at the game. Next, I removed the Central Processing Unit (CPU) from the game and reseated the Slot CPU Video board as well as the integrated circuit chip located in socket XU1. Although this step had fixed this problem previously, the game was still plagued with the missing graphics.

I took my trouble shooting to the next and highly underrated skill of swaptronics. I removed the CPU from an operational, neighboring game and replaced the one in my faulty game. The problem was cured.

Now having a functional CPU and a non-functional CPU in front of me, I could narrow my problem down further. I began by removing and replacing the Slot CPU Video board from the bad CPU with the one from the good CPU. I again returned my CPU to the game and again, it worked. I now knew that a component on my Slot CPU Video board was defective.

The next logical step was to remove the chip located in XU1 from the bad Slot CPU Video board and replace it with the good one. This chip simply plugs into the socket and requires no desoldering. I returned the CPU to the game and again I had graphics. The chip was replaced and the slot machine was up for play.

-Bart Holden


**Brrrrrrrrrrrr.... It's cold at the Little River Casino in Manistee, Michigan. Recent graduates from Randy Fromm's Casino School include (left to right) Slot Tech Magazine contributing writer Jon Hughes, Duke Edmondson, Tim Chandler, Joe Tighe, Tina Mcpherson and Sean Padden. Casino School instructor Randy Fromm is on the far right.**

# UNDERSTANDING DIODES AND TRANSISTORS

Do you remember when you first started working on slots? Remember when you didn't even know what a transistor was, let alone how to test one to see if it was good or bad? Now that you've been working on power supplies and monitors for a while, you probably can't recall a time when you didn't know how to test transistors and obtain substitute components.

If you can call to mind the difficulty of those early days, you'll understand why I occasionally take a step back and take a look at some of the fundamentals of troubleshooting. Of these basic skills and procedures, none is more important than the ability to test transistors. If you are already familiar with transistors, this discussion will probably be a complete bore. Consider yourself fortunate to possess such a vital skill and move on in the magazine. I'll catch you next month.

Still here? That's good because you just gotta learn how to test transistors. It's really the whole basis for troubleshooting monitors, power supplies, drivers for diverter coils and a host of other things electronic.

The basic philosophy is simple. Since many circuit faults are caused by transistor failure, we don't always have to know exactly how the circuit works in order to repair it. All we have to do is test the transistors in the circuit and replace the ones that are bad. Since transistors all test the same (with a few exceptions) once you've mastered the test you can fix just about anything!

## Diodes

We use the "diode test" function of the meter to test both transistors and diodes. Let's take a quick look at diodes first.

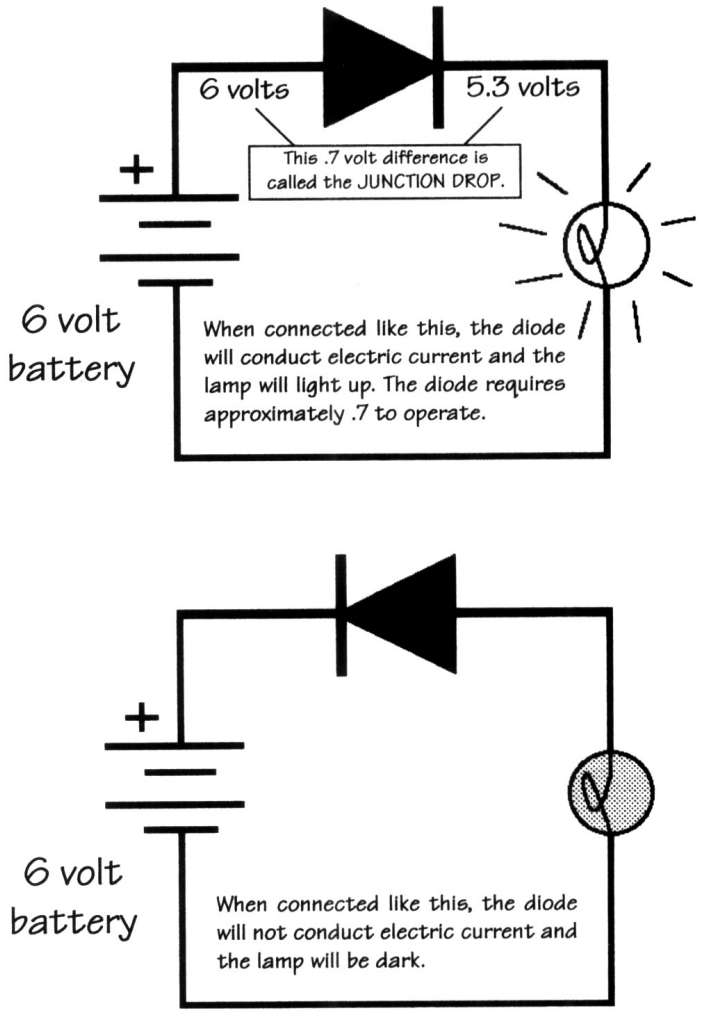
The diode is the simplest semiconductor that we have. The schematic symbol looks like an arrow with a bar at one end. The arrow symbol makes a lot of sense since a diode is a one way gate for the flow of electric current. It's kind of like the turnstile at a supermarket or amusement park where people are allowed to move through the gate in one direction only. A diode has just two component leads. They're called the "anode" and the "cathode."

It's interesting to note how the diode actually works inside. Just about all of the diodes we use in games are made of an element called silicon. In its pure form, silicon is an insulator. It cannot pass any electric current through itself. During the manufacturing process, small quantities of impurities called dopants are added to the silicon. The addition of the dopants causes a change in the structure of the silicon atoms.

When phosphorus is added to the silicon crystal, extra electrons are added to the silicon. This gives the silicon a net negative charge, with some free electrons scooting around inside the crystal. We call this type N silicon; N for negative.

When boron is added to the silicon, it develops a net positive charge. We call this type P silicon. We can think of type P silicon as having atoms with "holes" in the electron shell, just waiting for an electron to fall into it. In fact, we call these atoms in the type P silicon "holes."

The diode is made from a single chip of silicon. One half of the chip is type P silicon; the other half is type N silicon. Where the two types of silicon come together, we




**A diode is like a one-way gate for electric current.**

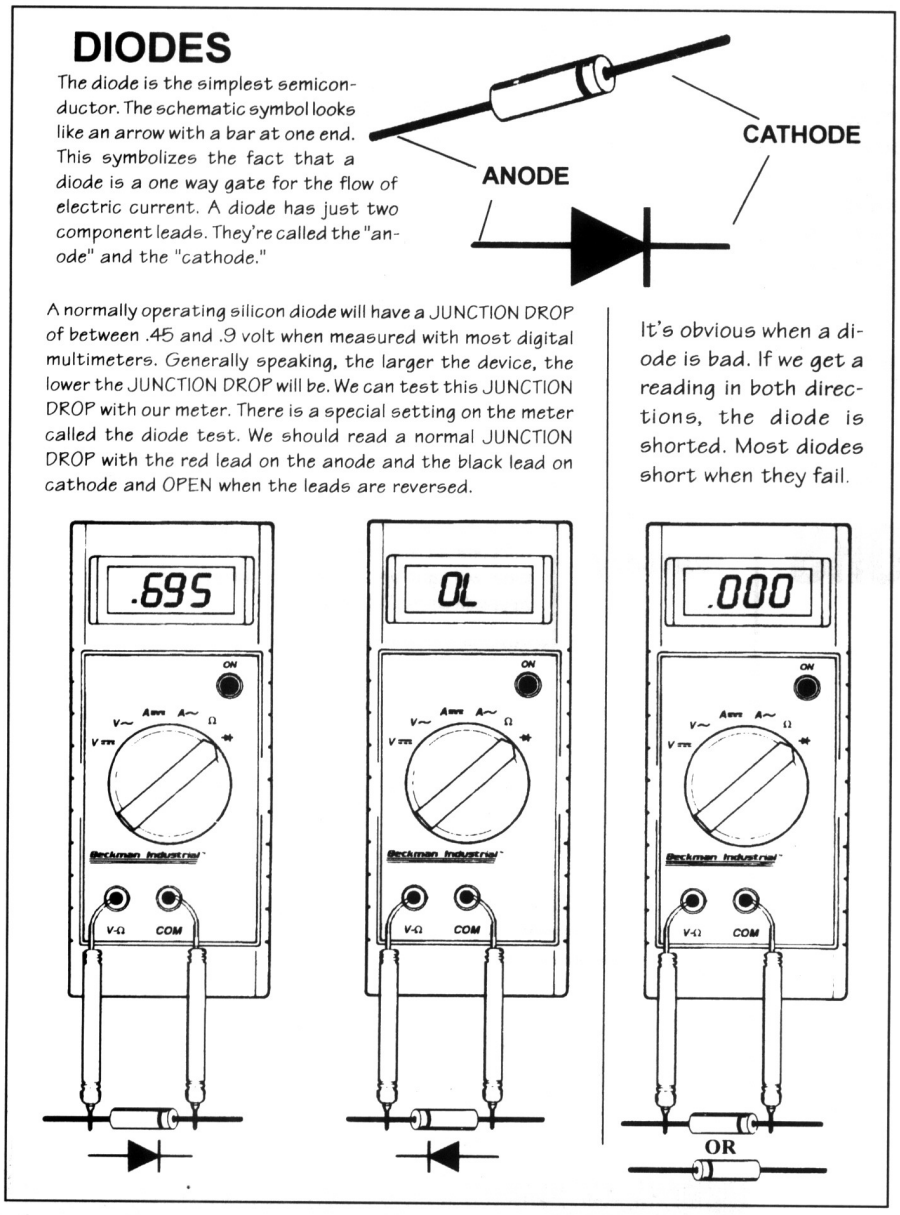
have something called the PN junction. The PN junction acts as a kind of barrier to prevent the free electrons in the type N silicon from reaching the holes in the type P silicon. When we test diodes and transistors, we will actually use the meter to test this PN junction. Your ability to test this PN junction will enable you to repair more electronic equipment than any other single test you will perform!

It takes a certain amount of voltage to push aside the PN junction and allow current to flow through the diode. It takes an average of .7 volt to break down the PN junction and allow current to flow.

Let's hook up this diode and see how it works. The anode is connected to the positive side of the battery. The cathode is connected to the negative side of the battery through the lamp. The electrons are repelled by the negative side of the battery toward the junction and the holes are repelled by the positive side of the battery toward the junction. Where they meet at the junction, the electrons fall into the holes. This pushes the PN junction aside and current flows through the diode.

If the battery is reversed, the holes and electrons are attracted to opposite ends leaving pure silicon as an insulator between them. The silicon insulator prevents current from flowing through the diode. This is why it is called a semiconductor. Sometimes it conducts; sometimes it doesn't.

It takes around .7 volt to break the barrier at the PN junction. This .7 volt is used up inside the diode as the energy required to push the current across the PN junction. We call this .7 volt the "JUNCTION DROP."




A normally operating silicon diode will have a JUNCTION DROP of between .45 and .9 volt when measured with most digital multimeters. Most engineers and technicians use the average of .7 volt when discussing the JUNCTION DROP. Generally speaking, the larger the device, the lower the JUNCTION DROP will be. We can test this JUNCTION DROP with our meter. There is a special setting on the meter called the diode test. When we use the diode test, we are actually measuring the voltage required to get through the PN junction. What we should see is a normal JUNCTION DROP with the red lead on the anode and the black lead on cathode (diode conducting) and OPEN when the leads are reversed.

This means that the diode is doing its job as a one way gate for current. When we read a normal JUNCTION DROP it means that current is flowing through the diode. When we read OPEN, the diode is blocking the current.

It's obvious when a diode is bad. If we get a reading in both directions, the diode is shorted. In fact, most diodes short when they fail. I'd say that 99 out of 100 diode failures are short circuits. If the meter shows OPEN in both directions, the diode is open.

You can usually tell if a diode is good or bad, even when testing diodes in-circuit. Needless to say, if you test a diode in-circuit and it appears to be bad, you should test it again after removing it from the circuit just to be sure.

## Diode Specifications

A diode is rated by voltage and current. The voltage rating of a diode is the maximum amount of voltage that the diode can block without breaking down. The voltage rating is listed as PRV (peak reverse voltage) or PIV (peak inverse voltage.)

The current rating is the maximum amount of current that the diode can safely pass without getting too hot. Believe it or not, we use the letter "I" to represent current. Huh??? Early experimenters thought of current as "intensity," so the letter designation "I" has remained with us. Io means output current.

When substituting diodes, you can always use a diode with a higher voltage and/or

current rating. Remember, the voltage rating of a diode has nothing to do with the voltage the diode is "putting out." It is simply a rating of the maximum voltage that the diode can block. You can replace a 50 volt, 1 amp diode with a 400 volt, 1 amp diode. You could also use a 50 volt, 3 amp diode or even a 400 volt, 3 amp diode as a replacement.

## Transistors

Transistors come in a lot of different shapes and sizes. The packages we commonly see in games are TO-3, TO-220, TO-218 and TO-92. There are two general types of transistors: NPN and PNP. Both are named for the way they are made. They're kind of like a sandwich with type N and type P silicon. The schematic symbol for the two types of transistors is basically the same. Notice that the arrow points away to designate an NPN transistor while the arrowhead points toward the center of the schematic symbol for PNP.

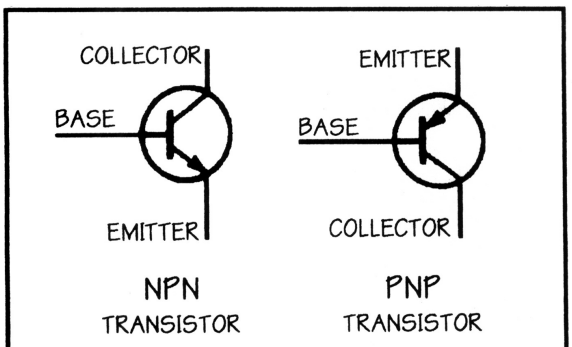
Since we're talking a lot about P's and N's here, chances are pretty good we're talking about a PN junction somewhere. In fact, each transistor has two junctions. The NPN transistor is made of a single chip of silicon that has one area made of type N material, a thinner region made of type P silicon and another N region on the other side. The PNP transistor has N silicon in the middle, surrounded by P silicon.

A transistor has three leads and each lead has a name. They are the emitter, base, and collector. There are two PN junctions in the transistor that we have to test. One is between the base and the emitter. The other is between the base and collector. It is the same test we used for the diode but we'll check two junctions instead of just one.

**TESTING TRANSISTORS**

Regardless of what type of package they're in, transistors will pretty much all test the same way. You'll need a digital multimeter with a "diode" test.

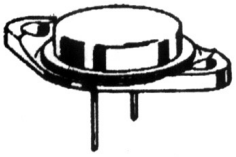
1. Set your meter to the diode test.
2. Connect the red meter lead to the base of the transistor. Connect the black meter lead to the emitter. A good NPN transistor will read a JUNCTION DROP voltage of between .45v and .9v. A good PNP transistor will read OPEN.
3. Leave the red meter lead on the base and move the black lead to the collector. The reading should be the same as in step 2.
4. Reverse the meter leads in your hands and repeat the test. This time, connect the black meter lead to the base of the transistor. Connect the red meter lead to the emitter. A good PNP transistor will read a JUNCTION DROP voltage of between .45v and .9v. A good NPN transistor will read OPEN.
5. Leave the black meter lead on the base and move the red lead to the collector. The reading should be the same as in step 4.
6. Place one meter lead on the collector, the other on the emitter. The meter should read OPEN. Reverse your meter leads. The meter should read OPEN. This is the same for both NPN and PNP transistors.

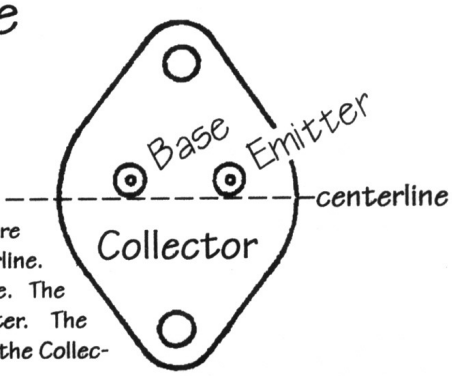



The schematic symbols are almost identical. If the arrowhead points out, it's an NPN transistor. If the arrow points in, it's a PNP transistor.

If the transistor fails any of these tests, it is bad. If you read a short circuit anywhere, the transistor is bad. As with the diode, you may attempt to test transistors in-circuit. However, transistors will often

TO-3 Package






Notice that the two leads are slightly offset above the centerline. The lead on the left is the Base. The lead on the right is the Emitter. The metal case of the transistor is the Collector.

| $I_C$ | $V_{CEO}$ | DEVICE TYPE | | $h_{FE}$ MIN/MAX |
|---|---|---|---|---|
| | | NPN | PNP | |
| 15 | 60 | 2N3055 | MJ2955 | 20/70 |
| | | 2N6576 | | 2k/20k |
| | | 2N5881 | | 20/100 |
| | 80 | 2N5882 | 2N5880 | 20/100 |
| | 90 | 2N6577 | | 2k/20k |
| | 120 | MJ15015 | MJ15016 | 20/70 |
| | | 2N6578 | | 2k/20k |
| | 140 | MJ15001 | MJ15002 | 25/150 |
| | 200 | 2N6249 | | 10/50 |
| | 275 | 2N6250 | | 8/50 |
| | 300 | 2N6546 | | 6/30 |
| 20 | 40 | 2N6257 | | 15/75 |
| | 60 | 2N3772 | | 15/60 |
| | | 2N6282 | 2N6285 | 750/18k |
| | 75 | 2N5039 | | 20/100 |
| | 80 | 2N5303 | 2N5745 | 15/60 |
| | | 2N6283 | 2N6286 | 750/18k |
| | 90 | 2N5038 | | 20/100 |
| | 100 | 2N6284 | 2N6287 | 750/18k |
| | 140 | MJ15003 | MJ15004 | 25/150 |
| | 200 | MJ13330 | | 8/40 |

**TRANSISTOR SPECIFICATIONS**

**$I_C$**
Collector Current
This is the maximum current (measured in amperes) that can be controlled by the transistor.

**$V_{CEO}$ or $BV_{CEO}$**
Collector-to-Emitter Voltage
This is the maximum voltage that the transistor can handle as measured between the collector and the emitter when the base lead is open (not connected.)

**$h_{FE}$**
Current Gain or "Beta"
This is an indication of the transistor's ability to amplify an incoming signal. The higher the gain, the less current it takes to drive the transistor. For example, a transistor with a gain factor of 100 will require just 1/100 amp of base current for 1 amp of collector current.

not test properly in-circuit and must be unsoldered and removed from the circuit for proper testing. Don't agonize over whether or not the transistor is bad when testing in-circuit. It only takes 30 seconds to remove the transistor and another 30 to test it properly. Just do it!

**Transistor Specifications and Replacements**

Transistors are rated much the same as diodes; maximum current and maximum voltage.

$I_C$- Collector Current - This is the maximum current (measured in amperes) that can be controlled by the transistor. Naturally, large transistors can handle more current that small transistors, just as thick wire can handle more current than thin wire. The largest size transistor we commonly use in games is the TO-3 package, which can handle up to 40 amps of current.

$V_{CEO}$ or $BV_{CEO}$ - Collector-to-Emitter Voltage - This is the maximum voltage that the transistor can handle as measured between the collector and the emitter when the base lead is open (not connected.) This is when the transistor is completely turned off and must block the current from flowing between the collector and emitter of the transistor. Although there are other voltage ratings for transistors, this is generally the only one that's important to us.

$h_{FE}$ - Current Gain or "Beta" - This is an indication of the transistor's ability to amplify an incoming signal. The higher the gain, the less current it takes to drive the transistor. For example, a transistor with a gain factor of 100 will require just 1/100 amp of base current for 1 amp of collector current.

We can lump most transistors into three general categories. Low gain transistors have a gain of up to 250. Medium gain transistors have a gain of 250-750. High gain transistors are those with a gain factor of more than 750. Admittedly, these figures are somewhat arbitrary.

Substituting transistors is just like substituting diodes. You can make the substitution as long as the replacement transistor is the same polarity (NPN or PNP) and has the same or higher voltage rating and current rating.

However, you should try to match the gain rating of the transistor as best you can. Substitute only low gain transistors for low gain transistors, mediums for mediums and highs for highs. This is not actually too difficult. As long as you're in the ballpark you should be okay.

Naturally, if you can obtain an exact replacement you should do so. Most cities have at least one electronic component retailer who carries a series of universal replacement components that can be used as substitutes. These companies publish an extensive cross-reference catalog that will allow you to make substitutions as quickly as locating a word in the dictionary. You simply look up the original part number of the component you want to replace and the index will tell you which substitute to use.

A cross-reference is also available online from NTE. http://www.nteinc.com/. You can download their cross-reference database as well, making it possible for you to cross-reference components without having to be on-line.

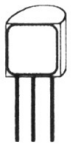
## TRANSISTOR SUBSTITUTION GUIDELINES

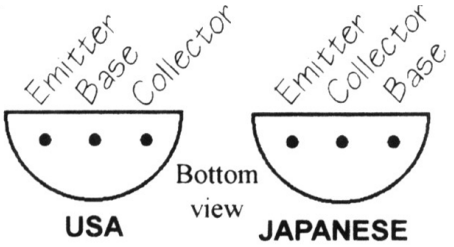
*It's as easy as 1-2-3!*


1. $I_C$ Use the same or higher.
2. $V_{CEO}$ Use the same or higher
3. $h_{FE}$ Try to match as closely as possible

### TO-92 Package

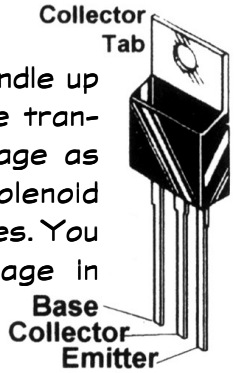
This is the smallest transistor that you commonly will find in monitors, power supplies and other circuits (other than SMDs or surface-mount devices). It is often called a "signal transistor" as it can handle only 1 amp of current.





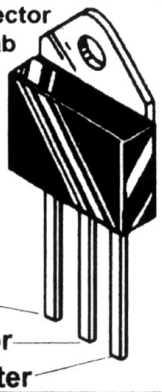

### TO-220 Package

This package can handle up to 10 amps. We use transistors in this package as lamp matrix and solenoid drivers in slot machines. You also see this package in power supplies.




### TO-218 Package

The TO-218 package is a larger version of the TO-220 package. It's used in many of the same applications as well. Most monitors use a TO-218 package for the horizontal output transistor.



# The Ambassador, the Slot Tech and You!

**By Frank Sutter**

I'll bet we've all had this experience: We have gone through our pile of job slips and we've discovered a real problem game. Typically, I put off tackling these games until I get to a slow part of the shift. Usually, I have been into the game earlier in the shift, and realized that this one was going to take more time then I could afford at the moment. While things are busy, I try not to tie myself up in a lengthy repair job. I normally close the game back up, leave it marked as down and leave myself free to attend to the more immediate concerns. These would include repairing the games left down from the last shift, any new games that might go down, answering the radio calls for customer assistance, and walking my section to change all the blinking and dark light bulbs. After all that is caught up, it's finally time to go back to those problem games.

The next move is go to the shop, grab the replacement parts I'm going to need to do the job, and review in my mind the special considerations that this particular job may require. Once I have made sure that the tools I need are on hand, it's time to get back into the game. The reason I have put this repair off instead of repairing it immediately is because it became evident as soon as I saw the problem that some extensive disassembly was going to be required in order to complete the repair. Now, with the tools and materials I need to do the job, and the prerequisite bitchin' and moanin', (under my breath, of course) I begin with the disassembly.

Of course, before I replace any defective parts with something from the shop, it's important to confirm that the replacement is actually going to fix the game. The most convenient way to do this on the floor is to use known-good parts from a nearby, working game. This means disassembling two games, but hey, that's what needs to be done. So, after a little more bitchin" and moanin', (under my breath, of course), I proceed to open and disassemble a second game. Before very long, I find myself with two games open, and parts scattered all over the floor and between the games.

Finally, just when I have decided exactly what is going to be needed to effect the repair of the problem game, just as surely as the sun is going to come up tomorrow morning, the radio will pick that moment to crackle to life. This is so normal, you will even come to expect it. I am normally already prepared to tell whoever is calling that I am tied up with a difficult repair, and that I will be there as soon as I am free.

This time, however, in my not so hypothetical situation, it's even worse then I expect. As I grab my pen and pad to jot down the location of the call, the news comes over the radio that I'm not going to be able to put this one off. This time the call is from a slot host requesting my assistance with a customer dispute! While desperately scanning the scene before my eyes, I sadly tell the host that it's going to be a few minutes, but I will be there as soon as possible.

Now what? I am going to have to leave two games down, and hustle over to the complaint before the time I am about to add makes the customer even madder then they are! I grab a couple of cups to put the small parts into, and I rest these cups in the games. Next, I'll quickly put the large game parts back in place, but I don't take the time to reconnect everything, because these games are going to be down until I can put them back together. I complete the required log entries, lock both games and pull the doors to make sure the locks are secure, and take a final glance to make sure the two games are marked as down. Finally, I shove all my tools back in my tool pouch, and I get on the radio again, telling the host that I am in route.

Now, my mind set shifts. I am about to arrive at a game that may or may not have a problem, but where the customer definitely has one. I know that I am going to have to keep a clear head to deal with the impending dispute, but all I can think about is the time that just got wasted because of this stupid radio call. I glance at my watch, hoping that I will be able to get the two games put back together and in playable condition before the end of my shift.

If you have spent two years of repair time on a casino floor, this situation, or a similar one, has probably happened to you more then once. When this happens to you, you must remember that you are about to become a representative of the casino, and that the impression that you leave on the customer and the slot host will be lasting, meaningful and important. For these reasons, I would like to review a series of guidelines I have collected that might help you insure that experience you are about to have is a successful one.

The first, last, and most important point to remember is that you must always exercise courtesy towards the patron. This may be the most difficult thing to accomplish since the customer might have been drinking, might have lost some money, and is undoubtedly convinced that he or she has been cheated by this infernal, blinking one-armed bandit. The biggest factor in your favor is that you are not the primary customer representative, and that your ONLY function is making the customer understand the way the game is supposed to operate. Hopefully, you already have a complete understanding of that topic, but remember that your supervisor is as close as your radio, so everything will be fine no matter what. Relax, greet the customer with a warm, friendly greeting, and be kind, courteous and polite.

Put yourself in the patron's position, and prepare yourself for rudeness! It may not happen, but you'll be better off if you are prepared for it. No matter what is said, don't retaliate. Try to keep in mind that the customer is mad at the casino and the game, not at you. Remain detached. It's a great idea to get the customer's first name early in the encounter, and use it as often as you possibly can. Smile, and if that doesn't work, smile some more. If it still doesn't work, smile even more.

Take extra care to avoid becoming overbearing or condescending, because that will only add fuel to the customer's fire. Instead, try to find out exactly what the customer wants, so that you can restrict your comments to the topic at hand, and avoid saying too much. Remember that you are not setting casino policy, or actually solving the customers' problem, but that your function is ONLY to explain, and if necessary demonstrate, the proper function of the game. You are the technical advisor, and while that function is important, even critical in this situation, it's also important that you remember your place. The supervisors who are on the scene are the ones making the big bucks, and this situation is one of the reasons why they get more money then you. Let them handle the customer.

Listen without interruption, and ask questions if anything is unclear. Remember to consider the customers' position, and don't forget the possibility that the patron may actually be right! However, if it looks like this is the case, remember that your

**Service Note: *IGT Player's Edge Plus***

**Error display that will not clear**. Display reads: Call Attendant - CMOS Data Problem does not go away after trying normal reset procedures. Problem is NOT in main board, motherboard or CMOS chip. Symptom persists after clearing with RAM clear chip.

**Possible Solution:** Press and hold self test switch until you hear an audible "ding" in the speaker. This may take up to 30 seconds so be patient. Close the door and turn the jackpot reset key.

employer is the casino, and that the validity of the patrons complaint should be shared in private with the supervisor at the scene before you admit the mistake to the customer. In most cases, the supervisor should be able to recognize this fact as the situation unfolds, and will normally jump right in to satisfy the customer as you offer your explanation of the proper function of the game. If this doesn't happen, KEEP YOUR MOUTH SHUT. Remember that there may be more to this situation then meets the eye, and that your are at the scene ONLY to confirm, explain and if necessary demonstrate the proper function of the game.

Now here's a bit of advice I probably don't have to tell you. As soon as the supervisor gives you clearance, go away! Before you do, however, there is one small task to complete. Even if the customer is found to be totally wrong and has been obnoxious and rude to you, apologize to him or her for their inconvenience. Then go a step further, and thank them for letting you be of service. Occasionally, this can be tough to do, but it's part of your job. Then get yourself lost in the crowd.

**"Relax, greet the customer with a warm, friendly greeting, and be kind, courteous and polite. "**

If the customer has been decent about the entire incident, it's not a bad idea to follow up. Just swing by the game a little later, and politely ask if the game is behaving itself now. It's a nice touch that may go a long way to change the customers' impression of your casino.

I hope that these guidelines help you in your job. If you stick closely by the advice I have written, you should be able to stay out of any serious trouble. I'll be writing more soon, so till next time, keep 'em runnin'!

**-Frank Sutter**
fsutter@slot-techs.com

# How Does it Know? A Touchscreen Primer

Ever wonder how touchscreens work? I mean, how does it know where you're touching on the screen?

In a nutshell, it goes like this:

The touchscreen is a pane of tempered glass with a transparent, thin-film conductive coating applied to the surface. A precise pattern of electrodes is printed along the edge on the conductive layer. To protect the otherwise delicate surface, a transparent glass overcoat is fused over the conductive coating.

This coating, dubbed ClearTek 3000, is actually a new process developed and patented by Microtouch. Older touch systems that lacked this protective overcoat would quickly wear out where an area of the screen was touched repeatedly. This is a really bad problem for gaming machines where the "bet" "deal" and "draw" virtual buttons are each just a small spot on the screen. As the conductive coating is worn away, touch sensitivity drops. Of course, this causes players to have touch the same spot repeatedly, exacerbating the wear in a death spiral of surface destruction.

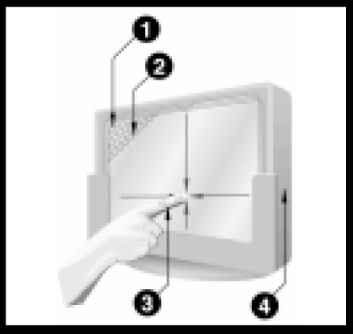
ClearTek 3000 is 210 times more durable than old touchscreens that lack protection, with over 20 million touches possible in any one spot on the screen. Put into perspective, if you touched a single spot on the screen every 5 seconds for 24 hours a day, you'd wear it out in no less than 3 years. ClearTek 3000 also makes the touchscreen extremely resistant to scratches as well. Likewise, the glass is all but impervious to chemical spills, having been tested with everything from lipstick, beer and coffee (all common items in a tavern environment) to brake fluid and sulfuric acid without any evidence of damage.

Voltage is applied to the screen through the electrodes on all of the edges. These electrodes are precisely engineered to provide, as much as possible, a uniform, low-voltage field throughout the screen. Any non-linearity is corrected at the factory by testing the screen and storing "linearization" values in non-volatile RAM (NOVRAM) in the touchscreen controller.

When you touch the screen, your body's capacitance (Yes . . . You are really a walking capacitor.) capacitively couples with the voltage field, drawing a tiny bit of electric current through the contact point. The current flow from each corner of the screen is proportional to the distance from the corner to your finger. Once these four values are determined, all you have to do is calculate the proportion of the current flow from each corner in order to locate the touch point.



**How ClearTek Capacitive Touchscreens work**




Voltage is applied to the screen **(1)** and the electrode pattern uniformly distributes the low-voltage field **(2)** over the conductive layer. When a finger touches the screen **(3)**, it "capacitively couples" with the voltage field, drawing a minute amount of current to the point of contact. The current flow from each corner is proportional to the distance from the corner to the finger. The controller simply calculates the flow proportions to locate the touch **(4)**.

Is the picture perfectly stable?

NO

Is the picture too small?

NO

Blank screen?

YES

Test primary fuse

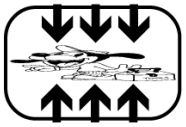
ok

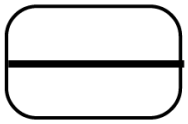
Is the monitor mak
ticking or chirping s
the sound of the po
"over-current protec
kicking in. You have
somewhere!

NO

YES

Is the picture shrunken like this? -or- collapsed to a horizontal line?





YES

NO

**You have a vertical deflection problem.**
Test for power at $V_{cc}$ pin of vertical output IC. Typically this is +24-30 VDC. If missing, series current limiting resistor may be open. Look for open 1.2 ohm or similar resistor.
**Vertical output IC bad.** Usually gets very hot when bad. Check for broken V. Hold control on remote adjustments board.
Substitute vertical output IC. Check electrolytic capacitors in vertical deflection circuit.

**Check the output voltage of the power supply (B+) .** T
between monitors. In Kristel monitors it can be as low a
some models. Typically, the B+ is between +115 VDC t
In some cases, there is more than one output. Consult t
diagram and measure all output voltages.

too low

Too high

Is it 0 volts?

Nope! It's just low

Yep

Replace all electrolytic capacitors in the SMPS (both in the primary and secondary).

It is not likely to be the largest primary electrolytic.

SMPS failure
Check for ope
especially low
wattage. Rep
lytic capacitor
side. Replace
controller IC.

Is the picture rolling from top to bottom ? (can't lock vertical hold.) Is the picture shifting left and right or scrambled? (can't lock horizontal hold)? Both?
Is there a severe, horizontal tear in the picture?
**You have a sync problem**. Test sync amplifier transistor. Substitute horizontal/vertical oscillator IC.

YES

**Too Much color? Missing a color?**
Check the video amplifier components, usually found on the neck board. Start with the video output transistors. Substitute video amplifier IC (usually LM1203). Remember, you can always swap components between the identical red, green and blue video amplifiers.

NO

**Screen has dark, ragged bars or dark patches, usually on the left side of the screen.**

This can be caused by a bad electrolytic capacitor on the B+ line. Look for a value of 47µf, 160 VDC. Could be located anywhere on the PCB.

NO

Is the picture distorted or curved?

YES

Ele
Th
in
yea
all
the
tim

**Flowchart by Randy Fromm**
**slot-techs.com**

# Generic Monitor Troubleshooting Flowchart

**Start here**

**Shorted MOSFET in SMPS**
(you'll find the FET on a heatsink near the yellow power transformer)
**Shorted AC input bridge rectifier**
**Shorted AC input capacitor (rare)**
**Degaussing Coil (rare)**
Try unplugging the degaussing coil. It might be shorted to the frame somewhere.

**BLOWN**

**Shorted horizontal output transistor.** Test with the diode check or ohms setting of your meter. Ground the black meter lead to the chassis and touch the red lead to the center leg or metal tab (collector) of the transistor. Open or high resistance is good. Shorted when bad. Test with power off!

**Output rectifiers in SMPS shorted.** These will be the diodes nearest the yellow power transformer.
**Bad high voltage unit (flyback transformer)**
**Retrace tuning capacitor(s) or S-shaping capacitor shorted**
**Diode modulator shorted**

**Yes!**

king a subtle ound? That's ower supply's tion" or OCP a short-circuit

Turn up the screen control. Do you see just a white screen (raster) perhaps with diagonal white lines running through the picture like this?

**Still nothing**

**YES**

This will vary s 88 volts for o +136 VDC. he schematic

**OK!**

**Test blanking or beam limiting circuits.**
**Check the video amplifier components, usually found on the neck board. Substitute video amplifier IC (usually LM1203). Not likely to be the video output transistors.**

Is the CRT heater glowing? (probably not) **Open CRT heater circuit.** Check for open series resistor, bad solder joints on high voltage unit.

Connect a 120 volt, 25 watt incandescent lamp between the SMPS output and ground.

**Now it's correct**

**You have a horizontal deflection failure.** Visually inspect the chassis for bad solder joints (especially around the high voltage unit) and hairline cracks in the PCB.

**! It's 0 VDC**

**Still too high**

Electrolytic capacitor failure in SMPS. Likely in the $V_{ref}$ input of PWM controller IC.

**0 VDC**

**Looks OK to me!**

**ok**

(Duh!).
en resistors,
v ohm, high
lace electro-
rs on primary
e PWM

Measure the DC voltage at the COLLECTOR of the horizontal output transistor.

**Same as B+**

Check the DC voltage at the collector of the horizontal drive transistor.

**Same as B+**

**0 VDC**

ctrolytic capacitor failure.
is is a common problem
monitors that are a few
ars old. It's best to replace
electrolytic capacitors in
e deflection circuits at this
e.

Horizontal drive transistor shorted.
Resistor between B+ and horizontal drive transformer open.
Look for broken connections on horizontal drive transformer.

Test horizontal drive transistor.
Look for bad connections on horizontal drive transformer.
Replace horizontal oscillator IC.
If all else fails, contact Randy Fromm for help!
e-mail help@slot-techs.com

# How Monitors Work

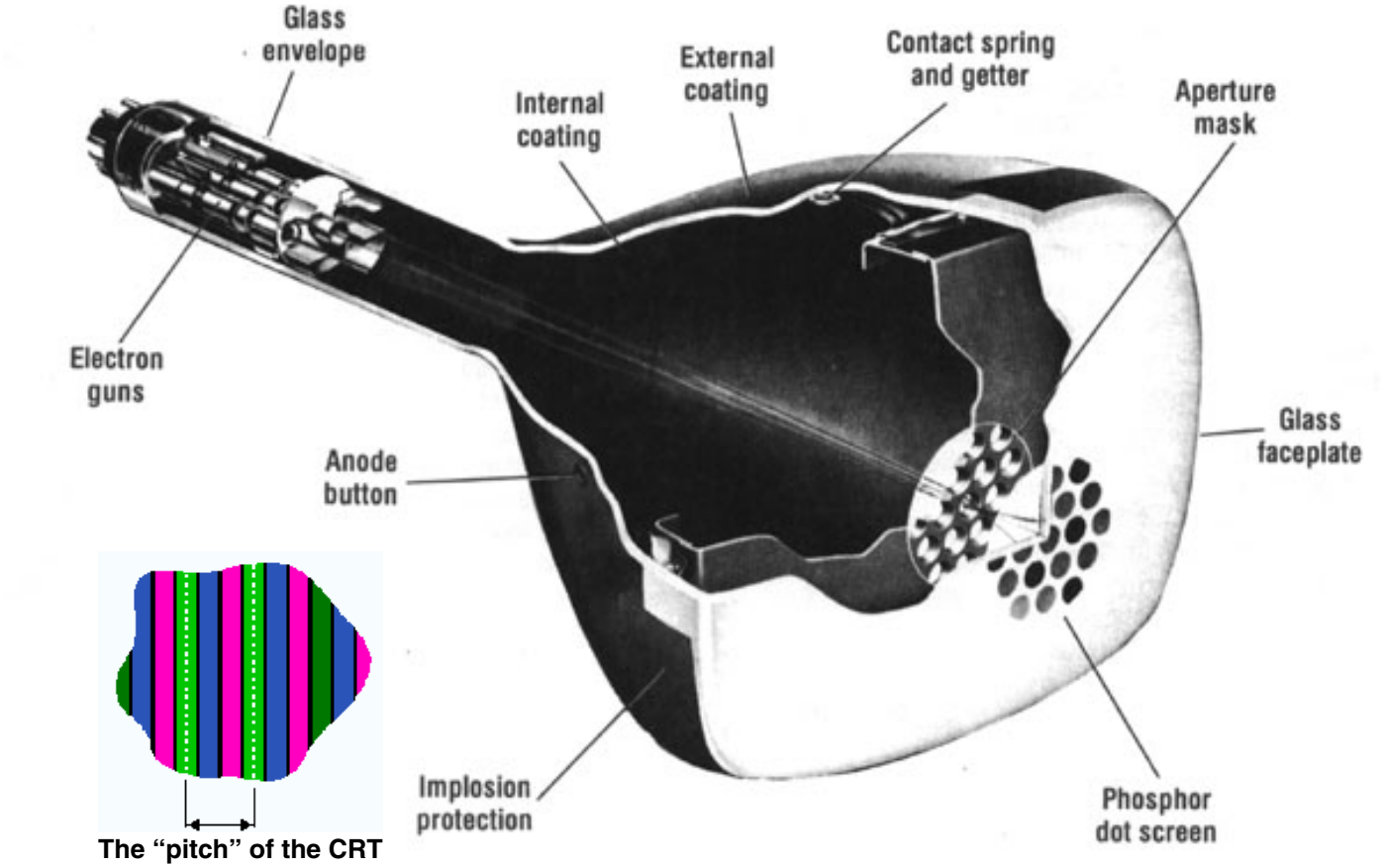
Video gaming machines are more popular than ever. Not the least of our responsibilities is video monitor repair. When you have hundreds of machines running twenty-four hours a day, three hundred, sixty-five days a year, monitor repair quickly becomes a priority.

Video monitors (also known as "raster scan" monitors) are easy to troubleshoot and to repair. Once we have a basic understanding of how monitors work, the vast majority of monitor problems can be isolated and repaired in well under an hour.

We can get a good idea of how the monitor works by looking at the picture tube. In the neck of the picture tube, there's a device called the "electron gun assembly." The electron gun does exactly what its name implies. It shoots out a stream of electrons. Electrons are the tiny, sub-atomic particles that surround the nucleus of an atom. The electron gun assembly actually consists of three, individual electron guns. There is a separate gun for each of the three primary colors: Red, green and blue.

In order to get an electron gun to emit the electrons, the "cathode" of the electron gun must be heated red-hot. The cathode is actually the source of electrons in the picture tube. In fact, the technical term for a picture tube is "cathode ray tube" or "CRT." When you see the reddish-orange glow in the neck of the picture tube, you're looking at the heater doing its job. To keep the heater from burning up, all the oxygen is removed from the picture tube. In fact, all gas is removed from the CRT during manufacturing. A picture tube is a "vacuum tube."

Coating the inside of the glass screen of the CRT is a substance called "phosphor." There are actually three different types of phosphor. The three different types of phosphor are laid down in alternating vertical stripes across the face of the picture tube.When struck by an electron from the electron gun, each one glows a different color. Each electron gun is precisely aligned so that its electrons strike only one color phosphor, hence the guns are referred to as the "red gun" the "green gun" and the "blue gun." By combining red, green and blue in different proportions, we can create any color we want. For example, red and blue create violet when combined. Adding red and green makes yellow! Blue and green mix to create a kind






The "pitch" of the CRT

of turquoise color called "cyan." When all three colors are added together, we get white. Conventional televisions and computer monitors work in exactly the same way.

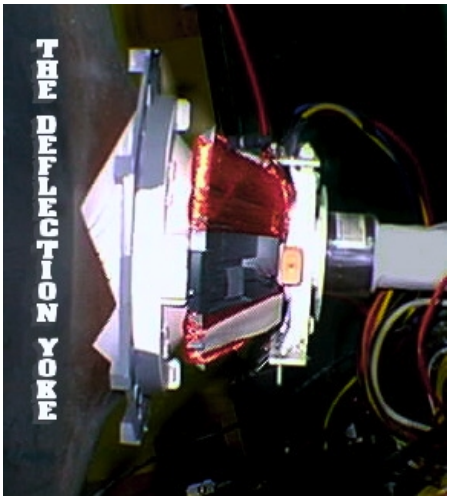
Note that the electrons do not pass through the glass front of the picture tube (glass is an insulator and will not allow the electrons to pass through) but bounce off and back into the picture tube. In doing this, the electrons have traded their "kinetic energy" (the energy of a moving object) for the light energy that we can see with our eyes.

Because the electron gun is securely fitted in the neck of the picture tube, Its aim is fixed at the center of the face of the CRT. We need a way to move the electron beam or our picture will be limited to a just a single bright spot in the center of the screen! To move the electron beam(s) on the phosphor-covered screen of the CRT, we use an electromagnet assembly called the "yoke."

The yoke is made of two pairs of coils of wire. When current is passed through the coils they create a magnetic field that "deflect" the electron beam(s) causing the spot to move on the screen of the picture tube.

One pair of coils is used to move the beam to the left and right. They are called the "horizontal deflection coils." The other pair of coils move the beam up and down. They are the "vertical deflection coils." By working together, the spot can be moved all over the front of the picture tube.

Let's see how the raster scan monitor creates the images on the front of the picture tube. When the electron gun is first turned on, the electron beam starts in the upper left corner of the CRT. The horizontal deflection coils (and the horizontal deflection circuitry of the monitor that drives them) cause the beam to move from the left edge of the monitor to the right edge. This draws a line across the top of the screen, called a




"Raster line." When the beam gets to the right edge of the CRT, it is turned off and quickly returned to the left edge again. This is called the "horizontal retrace." While the horizontal deflection circuit of the monitor is making the beam move from left to right and back again, the vertical deflection circuit is driving the vertical deflection coils in the yoke, dragging the beam down from the top. When the horizontal retrace is completed, the beam ends up in a slightly lower position than before. The next horizontal line will be drawn just slightly below the first one. The process is repeated until somewhere around 250 individual, horizontal lines have been drawn.

It's important to note that the lines are drawn only from left to right. During the horizontal retrace time, all three electron guns are turned off. There is a circuit in the monitor called the "blanking" circuit that turns off all three electron guns during the retrace. This is important because if the guns were allowed to turn on during the horizontal retrace (as the magnetic field of the yoke resets to start the beams on the left side of the screen) we would see a thin, diagonal line sandwiched between raster lines.

At this point, the electron beams are down in the lower right corner of the CRT. They have drawn one screen full of raster lines. A single pass of the beams from the upper left-hand corner at the top of the screen to the lower right-hand corner on the bottom is called a "field."

After drawing a field, the beams must now return to their starting point at the upper left corner of the CRT. This is called the "vertical retrace." But we cannot allow the beams to draw a line as they return from the bottom to the top of the screen. Remember the blanking circuit? The same circuit that is used to turn off the electron guns during the horizontal retrace is now used to turn off the guns during the vertical retrace as well. In fact, the blanking circuit is probably most important during the vertical retrace as we'll see below.

Once the beams are returned to the upper left corner of the CRT, they are turned back on and the process is repeated, 60 times a second. Note that the horizontal deflection circuit has to make the beam travel back and forth across the screen some 250 times before the vertical deflection circuit completes a single trip from the top to the bottom. Consequently, the frequency at which the horizontal deflection circuit operates is much higher than the frequency of the vertical circuit. The horizontal deflection circuit operates at approximately 15,750 hertz (cycles per second) while the frequency of the vertical deflection circuit is 60 hertz.

Because the horizontal deflection circuit is operating so much faster than the vertical deflection circuit, an interesting but hidden phenomenon occurs during the vertical retrace. As the magnetic field in the vertical deflection coils reverses polarity (to begin each field at the top of the CRT) the quickly scanning horizontal deflection circuit actually makes the beam move back and forth a dozen or so times before the beams reach the top of the screen. Turning up the brightness will often reveal these hidden "vertical retrace lines" that zig-zag their way across the screen. This is actually the path the beams take as they make

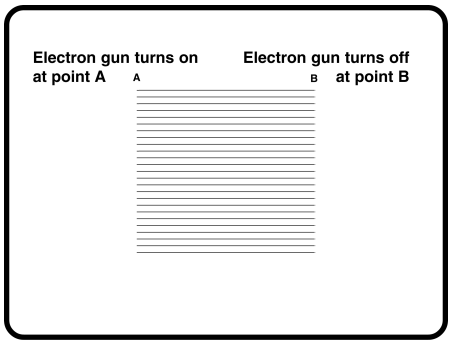
their way from the bottom of the screen back to the top. Naturally, these lines are normally hidden from view. They are concealed by the blanking circuit as it is activated during the vertical retrace. Remember the blanking circuit turns off all three electron guns during the retrace time. If you see these vertical retrace lines, you may have a problem with the blanking circuit.

Now we have a way to fill the entire screen with "raster," but we still do not have any kind of image. At this point, all we can make is a solid field of white, gray or colored raster. How can we make the images appear on the face of the CRT? It's easy! All we have to do is turn the electron guns on and off at the right times! When an electron gun is turned on, its electrons hit the colored phosphor and we see that color on the screen. When the electron guns are off, the screen appears black.

A group of three signals are sent from the computer in the game to the circuits in the monitor that control the three electron guns. These signals are called the "video" signals and the circuits in the monitor that control the electron guns are called the "video amplifiers." By controlling the amounts of red, green and blue on the screen we can make any picture we want. This is known as the RGB system.

The three electron guns are driven by the three video amplifier circuits. When the computer wants something to appear red, it sends a signal to the red amplifier. If the computer wants something to appear blue, it signals the blue amplifier, and so on. The higher the voltage, the brighter the color will be. Typically, the color will begin to appear on the screen when the video input signal is at 1 volt and the gun will be fully turned on at around 4 volts.

Other colors are made from combinations of the three primary color. For example, to make the color yellow, the same signal is sent to both the red and green amplifiers. Because the phosphor stripes are so close together, our eyes and brain combine the colors and we see yellow!




Let's draw something on the front of the screen. For example, suppose we want the monitor to display a red box in the center of the CRT. As the horizontal section of the monitor is "sweeping" across the screen from left to right, and the vertical section is "sweeping" down, the red electron gun remains turned off until it reaches point A. The gun is then turned on and kept on until the horizontal deflection circuit brings the electron beam to point B. At point B, the electron gun is turned off again. It stays off until it reaches the right edge of the screen, retraces back to the left edge of the screen and returns to the point just below point A (the next "raster line" down). The electron gun is then turned on again, and a second line drawn just below the first, ending just below point B. The process is repeated until the entire box has been drawn. Although the box has been drawn with individual horizontal lines, the lines are so close together that we see it as a solid red box.

In order for the monitor to display the images properly, it has to be "synchronized" with the computer that is generating the video signal. Without synchronization, the box that we just looked at would be completely scrambled. It would appear something like a pay TV channel on cable television. In fact, the most common method used to scramble a pay TV channel is a scheme called "sync supression" where the synchronization signal is removed from the channel and you pay to get it back. What you're doing is buying the sync!

In addition to the three video signals for red, green and blue, the computer also generates two "sync" signals. There is a "horizontal sync" signal that comes at the end of each line. The horizontal sync signal tells the monitor to stop drawing the horizontal line and quickly retrace to the left side of the CRT to begin the next line.

The "vertical sync" signal that occurs when the beam is down in the lower right corner. The vertical sync signal tells the monitor to start the vertical retrace sequence, turning the electron gun off and returning it to the top of the CRT.

The sync signals have a separate input to the monitor. In some cases, there is a separate connection for both the vertical and horizontal sync. sometimes, the vertical and horizontal sync signals are combined

**Vertical sync prevents the picture from rolling as shown here.**

at the computer to form something called "composite sync."

Computers may produce either one of two types of sync signals. The vertical and horizontal sync signals may be "positive sync" or "negative sync" Positive sync starts at around +5 volts, and pulses briefly down to 0 volts and back to +5 volts. Negative sync does just the opposite. It's normally at 0 volts, pulsing briefly to +5 volts and back in order to synchronize the monitor.

Both sync systems are equally effective. The designer of the game's hardware simply chooses one system or the other. In order to make their monitors compatible with any computer system, most monitor manufacturers have designed their monitors to accept both positive and negative sync inputs. In some monitors, the negative sync is connected to the monitor through a separate connector. Some monitors use a switch to select either positive or negative sync, others are designed to accept either sync polarity at a single connector; automatically detecting its polarity.

A monitor with bad horizontal sync

The best way to understand sync is to see what happens to a monitor without sync. If a monitor loses vertical sync, the picture will roll from top to bottom or from bottom to top EXACTLY AS IF YOU NEED TO ADJUST THE VERTICAL HOLD (also known as "vertical frequency") CONTROL. Naturally, if you see a rolling picture you will try adjusting the vertical hold control. If you can get the picture to slow down but it never locks in place, you have a problem with vertical sync.

Loss of horizontal sync can be a bit more difficult to recognize until you know what to look for. If the horizontal sync is just barely out of wack, the picture may be seen as shifting from left to right or vice-versa. Generally, the picture will be completely scrambled (worse than a scrambled pay TV channel) with little segments of diagonal lines all over the screen. Nothing will be recognizable on the screen. Again, try adjusting the frequency control (this time the "horizontal frequency" or "horizontal hold" control) to see if you can lock the picture in place. If not, you most likely have a problem with horizontal sync.

So, the picture is actually made from electron beams that are scanning across the screen from top to bottom, being controlled by the three video signals and two sync signals that come from the computer. Although we now have a way to control the electron beams, we still have another problem to overcome before our monitor will work properly. Remember when we looked at the beam of electrons as they left the electron gun and struck the glass front of the picture tube? The electrons struck the phosphor coating the inside of the glass, and bounced back into the picture tube. But what happens to the electrons now? An electron is a real, honest-to-goodness physical particle of matter, so it cannot just disappear! If we leave the electrons alone, however, our monitor will not work. If left to themselves, the electrons will form a negatively charged cloud inside the bell of the CRT. This negatively charged cloud will repel the beam of negatively charged electrons as they try to get from the electron gun to the front of the picture tube, preventing them from reaching the phosphor and producing an image.

**The flyback transformer**

This problem is solved by a part of the monitor called the "high voltage unit." The high voltage unit is also known as the "flyback transformer." All monitors and television sets have a high voltage unit. When they say "high voltage," they are not kidding! The high voltage unit in video gaming monitors can produce +20,000 volts DC or more!

The inside of the bell of the picture tube is covered with a metallic coating that conducts electricity. It's called "aquadag." On the top of the picture tube is a small metal plug called the "second anode" of the picture tube. The second anode is connected to the aquadag that coats the inside of the CRT, and the high voltage is connected to the second anode.

Now, an electron that has struck the front of the CRT and bounced off is immediately attracted to the positively charged aquadag and literally sucked out of the second anode by the high voltage. The high voltage is essential to the operation of the monitor. If you lose the high voltage power supply in a monitor, you will not see anything on the screen!

**Part 2 of "How Monitors Work" will appear in next month's issue (May, 2001) of Slot Tech Magazine**

# Educational Experience

**By Scott Reynolds**

***Scott Reynolds recently graduated from The Green Valley School of Gaming in Las Vegas, Nevada where he took their course in slot repair. He shares his experiences as a student with Slot Tech Magazine:***

One thing you should know before getting involved in any Slot Repair course is that when you graduate, you will possess the knowledge to gain employment as an "Entry Level" tech. This may seem obvious to some, but a lot of people think that by taking a course, it will put them on a fast track to the top; this is not true, as with any other profession, you must begin at the bottom and work your way up.

The course I took consisted of three modules:
* Module A: Basic electronics, bill validators, coin comparitors, an introduction to Regulation 6A and Mikohn Progressive Systems.
* Module B: Gaming machine theory
* Module C: Gaming machine lab

**Module A:**

Basic electronics: This was very basic indeed, just what you needed to know to get by. Unless you want to become a "board" or "bench" tech, you will not run into much that is not covered in this part of the course. You will learn the fundamentals of AC & DC voltages and basic multimeter use including how to test for continuity and resistance; wiring diagrams are also briefly covered. If you would eventually like to try for the jobs mentioned above, I would suggest at least a college course in electronics.

Bill validators: The DBV (Dollar Bill Validator) and WBA (World Bill Acceptor), both made by JCM, are the most common found in Las Vegas. There are others, such as the Mars validator but they were not covered in the course as they make up a very small percentage of the validators used here in Las Vegas. An oscilloscope along with a test board is used to calibrate the DBV, checking magnetism, black, white, color and a few other sensors. As entry-level techs, it is doubtful that this would be part of your duties but it is a useful skill to have and can look impressive on a resume.

Coin comparitors: These devices are used to differentiate between good coins and slugs. They do this in several ways: a sample coin is inserted into the mechanism to gauge diameter while three sensing coils determine if the metallic content of the coin being dropped is within tolerance. Coin Mechanisms Inc. manufactures most of the coin comparitors used in slot machines. They have many different models to choose from and can be calibrated using any multimeter that can measure down to millivolts (mV).

Regulation 6A: This regulation is in place to prevent the laundering of money through a casino. For more information on this regulation, contact your local gaming control board.

Mikohn Progressive Systems: Mikohn developed the progressive system casinos use in displaying jackpots for slot machines and several table games. They also manufacture the signs used to display this information. You are taught how to program these signs and troubleshoot communication problems associated with them.

**Module B**

Gaming Machine Theory: This is where all the different slot machines are covered: Bally, IGT, Williams, Sigma, Universal, Atronics, VLC and more. In the class where I was enrolled, only the first five machines listed above were covered; Atronics and VLC are growing in popularity in a lot of the smaller casinos here in Las Vegas though, and are worth mentioning. Gaming machine theory basically familiarizes you with each machine, its nomenclature and troubleshooting. While most machines are fundamentally the same, there are differences in terminology from one manufacturer to the next as well as different ways to reset tilts. Video slots and video poker machines are, for the most part, simpler to work with as they provide the most feedback via the video monitor.

At the other end of the spectrum, error codes and testing done on reel slots are more challenging because all you have to deal with in most cases are 1 - 3 digit LED read-outs; you must use a numeric code to decipher error messages and step through self testing. The exception to the rule is the Sigma Slot, which has an "LED Message Center" (11-character display) that can help immensely in determining a problem or running a test. Most of the casinos will have pocket sized booklets you can carry that tell the codes and common test modes for each of the different machines. Theory is, by and large, the driest part of the course. Twelve different machines covered in ten days, also made it the most frantic.

**Module C**

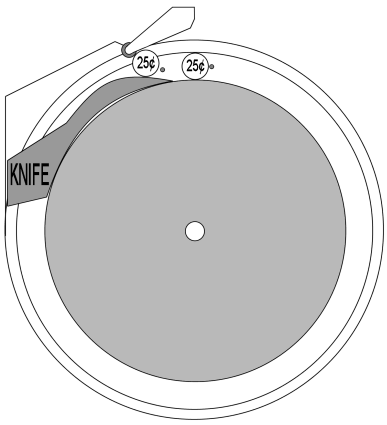
This is where all the theory paid off. We were actually turned

loose on the machines and permitted to test everything we had learned. The instructor would simulate a problem on a machine and we were allowed to diagnose and "fix" it. This was for me, the best part of the course and it really gave you a feeling of accomplishment when you were able to figure out why a machine behaved the way it did. Let me explain some of the problems we encountered in class:

**A Bally ProSlot has a "32" tilt code on the display when you walk up to the machine.**

If there is a tilt code present, when you arrive at a machine, it must be cleared before any further troubleshooting can be done, In this case, to clear a tilt, you would press the reset switch. If the tilt code returns, you would check the area in question. In this case, a "32" tilt signifies a "Hopper empty." This error code pops up when the hopper is empty or while, during a payout, the optic that counts the coins being dispensed to the tray does not count a coin for a predetermined number of seconds. You open the machine up only to find that there are plenty of coins in the hopper.

Upon closer examination, you see two coins jammed under the knife (see illustration) preventing any further coins from being dispensed. The hopper continues to run briefly, but when the time out is reached, a "32" code flashes signifying a jam. You remove the jam, replace the hopper and once the door is closed, the machine resumes payout as normal.






**An IGT PE Plus video poker machine has a "Door Open" error message on the screen preventing game play.**

You open and close the door to the machine (resetting the game) but the error message returns. An IGT PE Plus has an optical sensor that tells it when the door is closed or open, a blocked or broken sensor can cause this error message. You open the door and check the wiring of the optics, everything looks fine. You then check the optic for dirt, find some and clean it off. When you close the door now, the error message is gone and game play can resume.

**While walking through the casino, a customer calls you over and complains that his video poker machine will not accept a bill.**

You look at the customers screen and realize he is trying to insert a bill while in the middle of a hand. You explain that the bill validator is disabled while a hand is in play. When the customer finishes, he tries his bill again; the machine now accepts it.

**A customer complains that a slot machine will not accept any coins; they keep falling through the machine and back into the coin tray.**


You check to see if the coin comparitor has power (it does), blocked optics (it doesn't) or a missing or incorrect damper weight (it's fine). Last but not least, you check the sensitivity potentiometer and find that it is out of adjustment. After making the proper adjustment, all works fine.

**A Bally ProSlot will not accept coins or bills.**

Upon further examination, you find that neither the coin comparitor or bill validator has power. After checking that all wiring harnesses are intact and plugged in securely, you notice that the "Coin mech. toggle switch" (a feature found exclusively in Bally machines) has been turned off. Once turned back on, all works perfectly.

These were just a few of the problems we encountered in training and our final exam. Some were more challenging than others but all gave a good example of things that can and will be seen by slot techs every day. In all, it was a fascinating course and I learned a great deal. Slot machines are no longer a mystery and I am looking forward to a promising career in this ever growing field.

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greenvalleygaming.com

**- Scott Reynolds**
sreynolds@slot-techs.com

**By Kinger! (UK)**

**Global CRITICAL Update**
'King of the swingers' and 'Stake yer claim' have been updated. Due to an intermittent "Hopper empty" fault that has arisen. Please fit the new EPROM as soon as possible.
King Of The Swingers is V1.6
Stake Yer Claim is V1.5
Call customer service on: 01992 464469 or download for free on: 01992 461702 from the Global Bulletin Board.

Global post code is: EN11 0NT, Please correct all databases and records to prevent delays.

**Barcrest CRITICAL Update**
You are advised of the following program update and strongly recommended to update your machines as soon as possible.

Big Brother awp, BBRO 1.0
King Kebab awp, KBAB 1.0
Psycho Cash Beast awp, 1.0
Frenzy awp, FRNZ 1.0

**Crystal Upgrade - Thank Your Lucky Bars**
Crystal Leisure suggest that owners of Thank Your Lucky Bars update to version 7.1 of the program. We queried a problem with Crystal a few weeks ago and they denied anything was 'odd' about the game informing us that there was no program update since our version, which was 0.4. Surprisingly, Crystal are now on version 7.1, so who doesn't know what??. The new update has been suggested as non critical, which is where I beg to differ, I say, if you have anything lower, upgrade NOW. Game balance is the reason, I'm annoyed it wasn't attended to earlier...a brilliant game ruined by the slow reaction by Crystal to an important query from our arcade team!. Things should improve now it's been realised.

**BARCREST PROGRAM UPDATE**

BARCREST - Advise of the following program update as soon as possible.

Machine: King Kebab
Current Prg Version: Kbab 0.4

Purpose of update: Correcting a problem with the operation of the "Follow Me" barcode feature.
Contact: 0161 830 6549

**Maygay - Critical updates**
Player reaction to the machine has resulted in mixed cashbox performance. To enhance game play and prizes available to the casual player, the software has been updated to change the end game and be more player friendly. Latest s/w: Non data, SS010000 - Data, SS010001. The software and instruction sheet is available from the Maygay spares department and will be on a loan basis, which must be returned to Maygay for prompt credit.

Others: Duff beer guide, SA000031
Secret agent, SA000060
Sir Winalot, SA000136
Pounds of the Baskervilles, SA000128

We don't normally feature club machines but there is a **critical update for Tutankhamun:** SC990041 (game manipulation)
**Skill with prize: Strike it rich:** SS000027 (Graphics card compatibility)
Countdown: SS010000 (Game play enhancement)

Spares: 01902 792304
BBS: 01902 792907

**Thomas Automatics - Change machine News**

Following an announcement in a previous technical bulletin, Thomas have finally approved the MkIV hopper for use with their products. They have now finalised software to allow the complete interchangeability between MkIIA or MkIV hoppers in their products.

Software is now available to provide note acceptance for the BoE new £10.00 note. As well as accepting the new note, all upgrades will include the latest counterfeit protection. 'Complete replacements' will be brand new readers adn will attract a twelve month warranty. 'Hardware upgrades' will be rebuilt in their technical workshop and will attract a three month warranty.

**WARNING:** Ardac S2000 banknote readers have been the subject of continual improvement with major improvements on the change from a wheel driven to a belt driven internal transport mechanism and form 16k to 48k processor. NO WHEEL DRIVE UNITS WILL PERFORM SATISFACTORILY WITH THE LATEST ACCEPTANCE SOFTWARE AND COUNTERFEIT PROTECTION, EVEN IF UPGRADED TO THE 48K PROCESSOR.

The proliferation of Scottish banknotes and the introduction of the new BoE notes has brought Thomas to a situation where the existing Ardac S2000 and WACS banknote readers simply do not have a great enough processing capacity to handle all the notes required.

In preparation for hte introduction of the Euro, Ardac have been developing a new processor board, with greatly increased processing capability, and it was decided that this new board was the only effective way to handle combined Scottish and BoE note acceptance.
The first sample of a WACS containing the new processor is currently with us for workshop and field testing and, once these tests have been completed, more information will be released.

NV4: All English and Scottish machines containing the NV4 banknote readers and dispatched from the factory on or after 30.10.00 will provide for acceptance of the new BoE £10.00 note. However, a revised data set is now available to include data taken from circulated notes and readers need to be returned to Thomas Automatics to be updated. 0845 1304444 email: service@thomas-a.co.uk

**InfoCash - ATM units**
All those running InfoCash ATM's should now have received the software update. This update improves the 'Surcharging message screens' on your ATM to bring them inline with current rules from Link. The option to cancel the transaction by the customer must now be made available on a separate screen.

InfoCash state that many of hte banks are not charging their customers 'Disloyalty fees' from 01.01.2001, they cannot, at this stage, confirm which banks are conforming to new regulation guide lines and which will be surcharging their customers in a different way ie by a card issuers fee or transaction fee. They hope, however, to see the end of the disloyalty fee over the next few weeks.

Astra - New Details
Astra Games Ltd, Brocastle Avenue, Bridgend CF313UX is the new address for Astra. Telephone lines are:
Main 01656 658658
Fax: 01656 672849
BBS: 01656 672846

**QPS **Critical** - Tutti Frutti**
Another update for this very popular machine, this time to correct error codes which were omitted in error during the last upgrade. Not too critical but it is if you have an error with no code to guide you, so: Version 2.2 is released hot on the heels of version 2.0 from around two weeks ago.

It's nice to see QPS are listening to their customers when they mention 'oddities' in their machines and then act on it immediately...if only other company's were as hot.

**-Kinger!**
**kinger@slot-techs.com**

**Are you a slot tech with something to say about service and repair? Join the team at Slot Tech Magazine!**

**Game type: IGT I-games**
**Problem: Excessive coin-out time outs**

*Hey, Mike - How about using Loctite or Glyptol or something to lock the screw in place? - ed*

This is a simple problem, accompanied by a simple solution. Perhaps a solution so simple I know several techs at a couple of casinos have overlooked it. On the coin opper, behind the coin-out optic and mounted on the same bracket is a small spring loaded arm. For some strange reason the mounting screw on this arm works itself loose and causes these games to lock up in the coin-out jam tilt when there's no evidence of any jam. Of course the coin out jam tilt is caused when the voltage supplied to the photovoltaic cell in the coin-out optic reciever is interupted for too long. This spring loaded arm obviously has a direct influence over the smooth flow of coins across this optic. Tighten this screw periodically and your problem will be solved.

- Mike Thomas
mthomas@slot-techs.com

**Game Type: IGT Addams family**
**Problem: Screen Locking up during play**

Since IGT has introduced the Addams family slot machine it has become very popular with customers. Unfortunately, periodically the screen display will freeze during play requiring you, in most cases, either to reboot the game or to swap monitors with the one next to it.

Neither fix is easy due to the very large and awkwardly mounted monitors and also the extremely long boot up period on the newer IGT video slots.

The solution (well, sometimes) believe it or not, is to walk up to the game and toggle the reset switch three times. Yes, I know it sounds like a joke. However, if you ask any of the IGT techs in my area, they will all confirm this. Of course they can't explain this phenomena but it works.

- Mike Thomas
mthomas@slot-techs.com

**Randy Fromm's Casino School Graduates from Speaking Rock Casino in El Paso, Texas. From left to right: Art DeLa Cruz, Victor Naj, David Frias, Rafael "Shorty" Gomez , Alice King, Ruben Acosta and slot manager Jay Rodela**

ADVERTISEMENT

# Randy Fromm's Casino School

## On-Site Technician training

**Randy Fromm's Casino School** is a practical, no-nonsense look at how gaming machines work and how to repair them when they don't. **No previous knowledge of electronics is required** to get the most out of the school. The Casino School is geared for those who want to learn how to fix gaming devices without having to learn complex electronic theory or purchase expensive test equipment.

Be prepared for six hours of accelerated learning each day. Class begins at 9:00 am sharp each day and continues until 4:00 pm. The Casino School provides each student with reference materials and troubleshooting guides that will be valuable aids for repairing equipment on location and in the shop.

**Students learn how to work with:**


### THE DIGITAL MULTIMETER

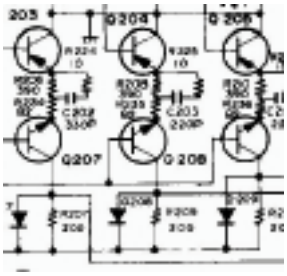
This relatively inexpensive piece of test equipment is easy to operate. Casino School students learn to use the digital multimeter to perform tests and measurements that will pinpoint the cause of a failure down to a single component.

### ELECTRONIC COMPONENTS

The individual components used in games are introduced. Parts such as resistors, capacitors, diodes, potentiometers and transistors are covered individually. Students learn how the components work and how to test them using the meter.

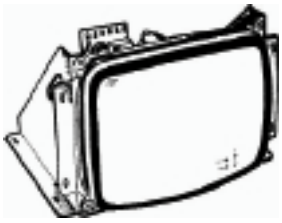
### SCHEMATIC DIAGRAMS

Schematic diagrams are the "blueprints" for electronics. Learning to read schematics is easy once you know how the parts work!



### POWER SUPPLIES

Power supply failure is a common complaint in many different types of systems.. Power supply failures are discussed during the class, along with shortcuts for troubleshooting and repairing them.



### MONITOR REPAIR

The monitors used in video slots are designed for quick, easy, and safe repair. Students will learn the theory of operation of all types of monitors and how to repair monitors down to the component level. Of course, monitor safety will also be discussed.

**You do not have to send your slot techs to Las Vegas or Atlantic City for training. Randy Fromm's Casino School brings the training to you. Contact Randy Fromm's Casino School today to reserve a date for your slot tech school.**

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## PARTS SUPPLIERS
## Electronic Components

Allied Electronics
401 East 8th St.
Fort Worth, TX 76102
(800) 433-5700

Caltronics
21315 Saticoy Street
Canoga Park, CA 91304
(818) 346-4936

Digi-Key
PO Box 677
Thief River Falls, MN 56701
(800) 344-4539

Fordham
260 Motor Parkway
Hauppauge, NY 11788
(800) 645-9518
(800) 832-1446 NY

Happ Controls
106 Garlisch Drive
Elk Grove, IL 60007
888-BUY-HAPP(289-4277)
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1355 Shoreway Road
Belmont, CA 94002
(415) 592-8097

JDR Microdevices
110 Knowles Dr.
Los Gatos, CA 95030
(800) 538-5000

MCM Electronics
858 East Congress Park Dr.
Centerville, OH 45459
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(800) 762-4315 (OH)

Mouser Electronics
2401 Hwy. 287 North
Mansfield, TX 76063
(800) 346-6873

Newark Electronics
4801 North Ravenswood Ave.
Chicago, IL 60640
(312) 784-5100

New Jersey Semiconductor Products, Inc.
20 Stearn Ave.
Springfield, NJ 07081
(201) 376-2922
(212) 227-6005

Parts Express International, Inc.
340 East First Street
Dayton, Ohio 45402
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Sintec Company
28 8th St.
PO Box 410
Frenchtown, NJ 08825
(800) 526-5960

Solid State Sales
PO Box 74D
Somerville, MA 02143
(800) 343-5230

Note: I use New Jersey Semiconductor Products, Inc. the most for semiconductors - ed.

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